EGNOS End-to-End Validation Programme

Context, Means, Issues, and Risks

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INTRODUCTION

The subject of this paper is the End-To-End validation and qualification strategy being laid out for the EGNOS Program. This paper is based on the following aspects:

1. Context of the EGNOS Program and the industrial partnership committed to providing the system,
2. An overview of the Assembly, Integration, and Verification (AIV) Program being developed by Airsys ATM as the Assembly, Integration, and Verification Contractor,
3. The methods of assessment that are planned (short-term vs. long-term),
4. The operational viewpoint of the EGNOS operator and the differences between the EGNOS Operational philosophy as compared to the Air Traffic Control Operational environment,
5. The means for conducting the End-to-End tests, including the some explanations regarding the planned use of equipment,
6. The approach or strategy of the overall Assembly, Integration, and Verification program and the involvement of Assembly, Integration, and Verification in virtually every aspect of the program from system design to operational readiness, and finally
7. A statement on the foreseen risks.

Within this strategy, there are two specific areas of concern with respect to the higher-level system, which will be discussed in this paper as well. They are the use of the in-factory Assembly, Integration, and Verification phase to conduct testing in an environment which is controlled and therefore, not available in the deployed system and the interdependence between the verification of system performance testing and certification of the system as a whole.

CONTEXT OF EGNOS AND THE EGNOS PARTNERSHIP

As with any complex project where Safety-Of-Life issues are involved, the industrial consortium providing the EGNOS system is built from the lead firms in their respective fields. Since the EGNOS program is overseen at the highest levels by the European Space Agency (ESA), there needed to be a consortium built with the required technical and industrial expertise created that would provide the program with the best overall chance of successful completion.

Alcatel Space Industries was selected to lead the consortium as both the prime contractor and the system designer. The overall responsibility for the design of the system resides with Alcatel Space Industries. At the Subsystem level, there are several firms providing the individual components or subsystems.

The Central Processing Facility (CPF) is provided by DaimlerChrysler Aerospace (DASA), also known as Astrium. Since the Central Processing Facility performs the function of collecting the raw information being received from the Signal-in-Space (SIS) by the remote stations and then providing the correction signal that is returned to the end user, it is critical that the subsystem design be correct, in both hardware and algorithm (software). Similarly, Astrium is providing, the Navigation Land Earth Station (NLES) which is used to transmit the correction signal derived by the Central Processing Facility to the Geostationary Satellite (GEO) for broadcast to the end user.

The Central Control Facility (CCF) is being developed and supplied by Alenia Aerospazio. The Central Control Facility performs the monitor and control function of the system as a whole as well as providing the archiving function for all data within the EGNOS System. It is the Central Control Facility that will control the service level available to the user as well as perform the “Network Operations Center” function. For example, the Central Control Facility monitors the health and status of all Ranging Integrity Monitoring Stations (RIMS), including the environmental conditions of the facility where The Ranging Integrity Monitoring Station is installed. In the event of a subsystem failure, the Central Control Facility operator can command the subsystem to reset itself or to go into a non-operational mode whereby to input to the system is produced from the failed subsystem. Simultaneously, the Central Control Facility archives all command information, particularly the issuing of any command that changes the operational status of a subsystem. Likewise, the Central Control Facility archives the correction message produced by the Central Processing Facility as well as the processed data from the Ranging Integrity Monitoring Station Stations.

The Ranging Integrity Monitoring Stations receivers and computers themselves are produced by different manufacturers, based on the type of receiver. The Ranging Integrity Monitoring Stations Type A and Type B, while virtually identical with respect to the specifications, are produced by Indra and the Type B by Alenia Aerospazio. This diversity of manufacturing is done to prevent a single point of failure from occurring due to a soft- or hardware flaw and is a common practice in Safety-of-Life critical systems. The third Ranging Integrity Monitoring Stations Type (Type C), developed for the express purposes of detecting the so-called “Evil Waveform” failure in the GPS system, is designed and developed by Racal Avionics Ltd.

Each of the Ranging Integrity Monitoring Stations, Navigation Land Earth Station, and Master Control Center (MCC) locations is connected by a communications system that has been named the EGNOS Wide Area Network, or EWAN. This network is comprised of a Frame Relay backbone connecting the majority of the Ranging Integrity Monitoring Station sites to the core network. The core network is based on Permanent Leased Circuits and connects the Master Control Center’s to each other in a full mesh topology and each Navigation Land Earth Station directly to two Master Control Center’s. In this fashion, no Navigation Land Earth Station is more than one router hop away from any Master Control Center. The entire network is provided by British Telecom (BT) and is managed jointly between British Telecom and EGNOS. British Telecom will maintain and manage the Frame Relay network (part of the Concert Frame Relay System) while the EGNOS management entity will monitor and control the EGNOS assets located at each individual EGNOS site.

Finally, there needs to be an entity that takes each of the above-mentioned individual parts and melds them into a working system. That role has been placed on Airsys ATM (AATM). Airsys ATM Gmbh, together with the other parts of the Airsys ATM concern, are tasked with the Assembly, Integration, and Verification task within the EGNOS Program. In order to fulfill this role, Airsys has built a mini-consortium of its own with sister firms within the Airsys ATM group as well as with Vitrociset (for the physical deployment and installation of the equipment) and with NLR (for flight trials). In making these selections, firms with core competencies that are outside those found within Airsys ATM will assist Airsys ATM to provide a operational system that meets the operational standards and requirements within the foreseen schedule.

ASSEMBLY, INTEGRATION, AND VERIFICATION PROGRAM

The overall EGNOS Assembly, Integration, and Verification program is built on the following set of steps:

1. Design Assessment
2. Validation of Equipment
3. Factory Assessment
4. Installation and Integration
5. Operability Assessment
6. End-to-End Tests
7. Initial Operations
8. Risk Mitigation and Troubleshooting

This series of steps provides a consecutive step approach which is based on the life-cycle of the program.

Design Assessment

In the initial phases, the design at system and subsystem level is reviewed to ensure that the system and subsystem meets its requirements. Early System Demonstration and Validation (ESDV), Reliability, Availability, Maintainability and Safety analysis (RAMS), Design Justification and Performance Budget Justification are performed at system and subsystem level in order to assess the system and subsystem design. . Assembly, Integration, and Verification places specific requirements on the subsystem suppliers prior to this phase in order to ensure that certain testability aspects are taken into account during the subsystem design. Some of those constraints might be that the subsystem can accept an external source of clocking in a test configuration or that a subsystem can be restarted from a specific rerun or restart point in order to make testing more effective and to allow identical repetition of a specific test. Assembly, Integration, and Verification has input into the Preliminary and Critical Design Reviews, with particular focus on testability and verification requirements.

Validation of Equipment

The equipment validation phase is often referred to as the Factory Acceptance Tests and makes the conditional acceptance of the subsystem from the subsystem supplier by the Prime Contractor. It is in this phase that the individual subsystems are tested against simulators and simulation agents in a controlled and sterile environment. This testing verifies that the subsystem itself functions as required, although it makes no statement as to the functioning of the subsystem when integrated as part of a larger, or whole system. This testing is conducted under the auspices and responsibility of the Prime Contractor with Assembly, Integration, and Verification in attendance as the System-level consultant. The requirements placed on the subsystem by Assembly, Integration, and Verification are verified as being fulfilled here by Assembly, Integration, and Verification, whether through specific test, demonstration, or inspection. This testing is conducted in the subsystem developers premises and is the final step before having the representative subsystem shipped to the Assembly, Integration, and Verification site for integration and test. This phase also marks the beginning for the majority of the subsystem suppliers for the beginning of recurrent unit production, although there is some risk involved in that there is a possibility of a flaw being found in the Assembly, Integration, and Verification environment that was not found in the factory acceptance test due to the changes in the test environment and the replacement of simulators specifically developed for testing with the actual subsystems that will comprise the system.

Factory Assessment

This is the phase where the actual work of Assembly, Integration, and Verification really begins in earnest. The subsystems are incrementally integrated into the test platform and tested to ensure that they do function together as a single system. As this step-wise installation and integration proceeds, greater levels of confidence are achieved in the overall system design. One of the purposes of this phase is to demonstrate that the individual subsystems do perform in accordance with the specifications and that the inter-subsystem interface control documents have been correctly implemented amongst all of the subsystem suppliers. It is in this phase where the majority of the troubleshooting (if required) would take place. This phase also provides Assembly, Integration, and Verification the opportunity to characterize the system behavior and to baseline the system in order to have a more concrete set of expectations that can be measured when the system is deployed. The ultimate goal of this phase is to provide the level of confidence needed in order to safely begin deployment of the system. In this stage, each of the individual subsystems is instantly accessible to both the Assembly, Integration, and Verification team and to the subsystem supplier's staff in case a problem is encountered. The Assembly, Integration, and Verification Factory Acceptance marks the "Go/No-Go" gate for deployment of the individual system components.

Installation and Integration

After the completion of the factory assessment, the actual deployment begins. In this stage, the physical equipment is actually delivered to the locations where it is to be installed, the equipment facilities are prepared, and the hosting entities become more intensively involved. The equipment is unpacked and inspected for damage. After the inspection, the equipment is installed in place and interconnected. This installation may include the installation of antennas, the connection of the equipment to the local power supply, positional determination of the antenna phase center (needed to set the "known" location information), and connection to the local facility environmental monitoring systems such as those that notify the EGNOS operator if there is a failure with the power or climate control systems within the facility. Once the actual installation is completed, the subsystems are also connected to the communications systems at the site and the equipment is powered on. A self-test is made and if the equipment functions correctly, an initial attempt is made to communicate with the remote Master Control Center. This leads to the Site Deployment Acceptance Test whereby the Master Control Center performs command and control actions with the subsystem at the site. This Site Deployment Acceptance Test ensures that the individual site is correctly installed and is accessible via the network.

Operability Assessment

The previous phase flows directly into this one since the end of the Site Deployment Acceptance Test is part of the beginning of the Operability Assessment. In this phase, the subsystems are exercised in order to ensure that they function together with the EGNOS Wide Area Network (EWAN) as a communications media instead of the factory environment. The collection of the SIS will begin in this phase as will the production of the EGNOS correction message. This data is recorded for post-processing and analysis as well as on-line processing. The Ranging Integrity Monitoring Station and the Test User Equipment both collect the data being provided by the Signal In Space (SIS), including that from the GEO. The Test User Equipment maintains an archive that is self-contained and that can be reprocessed in the Test User Equipment using various filters. The Operational Procedures are also considered in this phase since some of the testing will involve certain aspects such as the regular transfer of control from one Master Control Center to another. In addition, the operability assessment is used to ensure that the EGNOS messages produced fall within the values assigned as "plausible" and correct.

End-to-End Tests
After the Operability Assessment has been accomplished, actual end-to-end testing is conducted. End-to-End testing will be a comparison of positional values from both the TUE and from the Ranging Integrity Monitoring Station data collected. It is in this stage where the "correctness" and accuracy if the EGNOS correction message is verified as well as some of the system behaviors. These behavior tests may include provoked switchover testing to verify that the service is not interrupted when redundant equipment is switched on-line, that the switchover between primary and secondary computational groups occurs correctly, and others. This is also the stage where the initial flight trials are conducted. Flight trials are used here in order to verify the results obtained from a stationary platform and to add additional confidence on the functionality of the system. At the end of this stage, the Operational Readiness Review is conducted.

Initial Operations
Occurring after the Operational Readiness Review, the Initial Operations phase has the purpose of providing the long-term statistical data to ensure that the accuracy, integrity, and availability of the system are met. Since the previous stages of operations with the actual Signal in Space are relatively short, the basis for a valid statistical analysis can not be achieved. The Initial Operations phase will provide the amount of data needed over time in order to provide a more accurate statistical basis for the analysis of whether the requirements are met. In addition, it is expected that the user community will be using this opportunity to conduct independent analysis of the EGNOS system. While strictly not part of the Assembly, Integration, and Verification program, it is important to note that there will be analysis that continues after the Operational Readiness Review.

Risk Mitigation and Troubleshooting
The entire Assembly, Integration, and Verification effort is designed to mitigate risk to the greatest extent possible while being aware that the system is to be ready by a specific target date. In order to mitigate the amount of risk inherent in a system such as EGNOS, the steps defined above have been implemented. In this manner, a logical and consecutive series of actions is laid out, starting with the initial design stages, that will provide an increasing level of confidence as the system is further developed and deployed.

Naturally, there will be anomalies that arise during any of the stages of Assembly, Integration, and Verification. When these anomalies occur, a systematic approach to troubleshooting is made. The scope of the Assembly, Integration, and Verification effort is bounded by the subsystem level. This means that, in the event of an anomaly, the occurrence is traced to the subsystem responsible by Assembly, Integration, and Verification. In this tracing, a detailed description of the problem, the steps taken to resolve it, and the conditions in which it occurred are described. This description is provided to the subsystem supplier, who determines where within the subsystem the problem lies. For problems occurring in a software module or hardware card within a subsystem, the subsystem supplier will be involved as they have all of the special tools and the expertise available to them in order to make the most efficient and effective effort.

SHORT- VS. LONG-TERM ASSESSMENT

One of the issues that confronts the EGNOS system, as well as WAAS and MSAS, is the duration of the assessment needed to verify requirements. This is particularly applicable to those requirements concerned with performance over time. In the relatively few months that are available between the end of the factory testing and the Operational Readiness Review, the amount of data available for analysis is not sufficient to provide a statistical analysis with a high level of confidence in the results. Simply put, the needs of the analysis are greater than the time allotted to it. Therefore, a sequence by which the system is verified, first during the in-factory stages using models and then moving to long-term assessment using the actual data under actual conditions is foreseen.

The use of models is specifically designed to reflect realistic conditions possible while maintaining control over the variables introduced into the system. Since the ability to repeat a test in exactly the same manner with the same conditions an unlimited number of times is a requirement on the Assembly, Integration, and Verification program, the in-factory scenarios, using models, are designed to meet that requirement. However, well-designed models also contribute significant amounts of confidence in the final results. While it is not foreseen to model worst-case scenarios during the initial Factory Assessment phases, the option to replay recorded data that contain “worst-case” occurrences may be required in the event an anomaly is noted that requires additional investigation and troubleshooting.

After the short-term analysis in factory, the assessment migrates towards a more long-term assessment of how the system actually functions on a day-to-day operational level with all of the inherent uncontrolled variables that are found. By recording the data that is received and generated during normal operations, we can use this data to model these effects in the in-factory environment in the case on an anomaly. This permits observation to determine if the event is reproducible and, therefore, indicative of a failure within a subsystem.

MEANS FOR END-TO-END TESTS

One of the issues that confronts the Assembly, Integration, and Verification effort is the means and equipment to validate and verify such a system, particularly in the end-to-end testing. The Test User Equipment (TUE) which is being produced by Sextant, will provide an independent means of verification. The purpose of the Test User Equipment is to ensure that the EGNOS correction message results are correct. For all intents and purposes, the Test User Equipment will be the forerunner of the actual user equipment with additional features. For example, the Test User Equipment will record the data received by it and allow that data to be replayed against various filter mechanisms. These filters include the masking of the GEO or GLONASS data and thereby computing the position based on a pure GPS solution, GPS plus GEO, or other configurations. As a static (not moving) receiver, the advantage of the Test User Equipment is that the position of the equipment (or the antenna) is precisely known using geodetic survey techniques so that any error in positional determination can be calculated and observed.

Another major contributor to the end-to-end tests will be that of actual flight trials. By using a TUE coupled to an airborne platform and antenna (basically installing the TUE into an aircraft), measurements can be taken and then the data processed off-line. The flight trials aircraft proposed will utilize airports with laser tracking systems that allow a ground-based positioning system with which to compare the EGNOS data recorded by the TUE.

Finally, the Ranging Integrity Monitoring Station themselves will provide data be used in the validation effort, first by Assembly, Integration, and Verification during the system integration & validation and then later, after the completion of the Assembly, Integration, and Verification effort, by the Performance Assessment and Checkout Facility (PACF) during the Initial Operations phase after the Operational Readiness Review. The Performance Assessment and Checkout Facility will use the Ranging Integrity Monitoring Station data since the Ranging Integrity Monitoring Station collect and process the raw SIS prior to delivering it to the Central Processing Facility, thus making the evaluation and analysis of the data easier. The data recorded during the systems integration phase may e replayed on the in-factory environment to observe that the system behaves in a manner which is expected, i.e. that the deployed system is not dramatically different than that in the in-factory environment or if it is different, that the differences are understood and explained.

APPROACH

The approach envisioned by Assembly, Integration, and Verification for EGNOS is one of providing the bridge between the early system assessment that is performed using models and the long-term assessment that is done using actual real data. While both means of assessment provide useful information for both the system verification and the actual requirements analysis, there are essential steps in the middle that the Assembly, Integration, and Verification program is expected to cover.

Assessment Based on Models or Prototypes

The initial assessments based on modeling or prototypes provide a means by which design flaws can be discovered while still in the planning and development stages rather than later when major expense and delay would be incurred. These assessments include the Early System Design Verification (ESDV), the Reliability, Availability, Maintainability, and Safety (RAMS) Analysis and the EGNOS System Test Bed (ESTB).

These analyses are directly linked to System Design issues such as the placement of the various Ranging Integrity Monitoring Station in order to obtain the most accurate assessment of Ionospheric conditions, delay, and effects of Selective Availability. In these analysis, models are used to perform “what-if” and trade-off analysis in order to produce the best overall results for the least cost. Best overall results include safety, integrity, best coverage, etc.

By using prototypes in the early system development, the basic design of the individual subsystems can be verified and modifications made before beginning large-scale coding or production efforts. However, prototypes, by their nature, are subject to a great deal of change and often suffer from “modification-on-the-fly” syndrome. So, while prototyping can assist greatly in the production of the final working system, prototypes do not contribute greatly to the overall confidence factor in the end system functionality due to the fact that they are a temporary solution.

Long-term assessment using real data
Long-term assessment provides what short term can not. Long-term assessment uses actual system data that has a myriad of uncontrolled variables, such as weather, ionospheric scintillations due to solar storms, atmospheric effects, and other factors that can not be adequately simulated in any model. In addition, long-term assessment provides a basis on which a valid statistical analysis can be conducted that results in a high level of confidence (high *p* value) that can not be achieved in a short-term analysis.

Additionally, the user community is expected to perform an independent assessment during this time in parallel. This allows an independent and somewhat objective viewpoint from which to judge the system performances.

Finally, the capabilities to perform this long-tern analysis are built in to the system itself and are meant to continuously add additional performance data to the analysis. In this manner, the performance requirements can be demonstrated in the long-term and over the lifecycle of the system.

Unfortunately, the major problem with the long-term analysis is exactly as the name itself implies, it is long term! An assessment that may (and will) encompass the entire 15 year lifecycle of the system is not a great deal of help to the user who needs to know if the system is reliable after the initial operations period has passed and the system has been placed into Final Operational Capability. The user needs to have confidence that the system functions correctly and to the requirements before they will place their trust (and their lives) in that system. Therefore, there needs to be an intermediate step whereby the needs of the user (confidence in the system in the near-term) can be balanced with the long-term need to monitor the system performance to gather data, analyze that data, and thereby recommend improvements.

Assembly, Integration, and Verification as the Intermediate Step Between Pure Theory and Pure Reality
The strategy envisioned by Assembly, Integration, and Verification melds the two different approaches into a single, continuous process. By performing testing with simulations in the factory environment and then replacing the simulator incrementally with the actual equipment as it becomes available, confidence in the individual subsystems function is increased. Likewise, as the subsystems ability to function together is demonstrated and proved with an increasingly complex system, the risks related to deployment of such a system are reduced. Finally, after the first set of equipment is deployed (Ranging Integrity Monitoring Stations, Navigation Land Earth Station, and Master Control Center) in sufficient numbers to provide an initial Signal in Space and producing user correction messages, actual data used to verify the functionality of the system as well as the performance requirements albeit on a shorter term than the long-term assessment. By using the actual data in the deployed system, confidence is gained in the final operational capability of the system to perform as it is supposed to in the final deployed configuration.

By using the actual "production-ready" equipment, the overall opportunity for success in the deployed system is increased and therefore the confidence of success as well. It is important to note that the testing conducted on subsystems that are identical to those being deployed and under configuration control has more validity and weight to the user than that done on prototypes, particularly when a failure or anomaly in a prototype can be caused by any number of factors, not the least of which is an actual design failure. However, failures in prototypes can also be caused by a variety of other factors that will never be seen in a production environment.

RISKS

Risk is one part of the program that is inherent and the larger the program is, the more risk. However, for Assembly, Integration, and Verification, there are four major risk categories that have been identified. They are:

1. Development (with respect to Schedule)
2. Deployment
3. Timing / Schedule
4. Remote Integration

Each of these risk categories is briefly described along with the actions considered for mitigation.

Development (as it impacts Schedule)
As with any program that is new, there is a substantial amount of development that needs to be done. For example, the need to produce soft- or hardware that is compliant with Safety-of-Life critical requirements practically eliminates any Commercial Off-The-Shelf products from consideration. Since such products are not commonly available, the need to develop such items becomes apparent. However, in any development there are risks of delay or that the item fails to function. In the frame of Assembly, Integration, and Verification, there is not a great deal of development of systems that are safety critical. However, the risk associated with development, in terms of the Assembly, Integration, and Verification program is that of delivery delays from the subsystem providers. For this particular risk, the Assembly, Integration, and Verification Platform is designed so that, in the event of a late delivery of a specific subsystem, that subsystem can be simulated and other subsystems, which were delivered on time can be tested. Therefore, there is an amount of flexibility within the testing sequence.

Deployment
One of the biggest risk factors is seen to be the deployment. Unlike the WAAS system where all of the sites were within a single country, the EGNOS system is spread from South Africa to Norway and from Singapore to Nova Scotia. In dealing with the different socio-political realities of the various countries, as well as the various levels of technology available in the infrastructure, a significant amount of manpower has been allotted to the deployment effort. Several iterations of inspections and site certifications are foreseen on order to ensure that the site is ready when the equipment is delivered to the site for installation. In addition, a single firm with extensive experience has been subcontracted to do the actual installation, deployment, and on-site integration.

Schedule / Timing
Seen as the most critical point of risk within EGNOS, the schedule / timing for equipment delivery is very tight. In order to minimize the disruption to Assembly, Integration, and Verification activities caused by the late delivery of a subsystem, the Assembly, Integration, and Verification Test Platform is designed to provide simulations of virtually any data within the system and thereby simulate the missing subsystem within a certain tolerance. Obviously, there are some aspects, particularly those relating to Monitor and Control functionality that

can not be simulated but the majority of the pure data aspects can be adequately simulated by the Assembly, Integration, and Verification Platform. Additionally, any failures in the deployed system that require troubleshooting also may place the schedule in jeopardy due to the constraints of getting a new subsystem or part to the location needing it.

Remote Integration

Another major risk for Assembly, Integration, and Verification is the need to "remotely" integrate various components of the system, particularly the outlying Ranging Integrity Monitoring Station Sites. By having the deployment team on-site for the Site Deployment Acceptance Test, Assembly, Integration, and Verification minimizes the risk that the equipment is unreachable and that the status can not be determined. However, in the event of a failure after the Site Deployment Acceptance Test when the site deployment team has left the site, the hosting entity will be required to respond. In some cases where the site is in a remote or unmanned location, this response time could be sufficiently long to jeopardize the schedule. However, by performing rigorous testing in-factory, the chances of having a failure on the deployed site due to an equipment failure is minimized.

CONCLUSION

In conclusion, it is clear that there are many challenges facing the EGNOS Assembly, Integration, and Verification program, particularly with respect to the End-To-End verification of the system. Technological differences between hosting countries, tight schedules, and the need to balance the concerns of the user regarding system stability against the system deployment and activation needs require concise and encompassing test planning combined with risk mitigation strategies. These plans include a phased, incremental testing approach coupled with a combination of controlled in-factory tests using simulations and deployed systems tests using real data.

The End-to-End system testing provides the user with the confidence that the system not only does function as required but will also continue to do so during the system lifecycle. By providing the bridge between the short-term testing using models and the long-term testing needed to establish an adequate sample size for the statistical analysis of the requirement, Assembly, Integration, and Verification provides the user with both current and future confidence in the EGNOS system.

With airspace in Europe, and indeed throughout the world, becoming increasingly crowded, it is apparent that a new form of navigation system is needed that provides a precise positional determination for both the pilot and the controller. In order to provide that system to the end user, Assembly, Integration, and Verification is involved in nearly every facet of the program from design review to final testing.

This paper is intended to provide an overall blueprint of the strategy for the end-to-end validation of the EGNOS system, as foreseen by the Assembly, Integration, and Verification contractor, the Prime Contractor, and the European Space Agency. The next step will be that of defining the precise steps, timing, and test plans for each of the various subsystems and then the system as a whole entity. Since this is a process that is currently under way, it is expected that, by this time next year (2001), these plans will be developed from the strategic, or higher level, to the actual day-by-day work plan level.